

Final Report for NASA Grant NAGW-4357 (SwRI Project 15-7130)

Ly α Photolysis in the Primitive Solar Nebula

70-92-CR2
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1 Introduction and Overview

This is the final report for the first two years of work on this project. For the third and final year, the grant has been given a new number (NASA NAG5-4290, SwRI project number 15-8939).

Our proposal is to quantitatively investigate the importance of photochemistry in the solar nebula. We are developing a Monte Carlo resonance line radiative transfer code, capable of accurately calculating the radiation field of H I Ly α , He I 584 Å, and He II 304 Å emissions throughout the nebula and the nearby interstellar medium in which it is embedded. This code will be tested on the current interplanetary medium through comparisons with extensive measurements by the *Voyager* spacecraft, in order to verify and validate it. Finally we will apply the code to several appropriate models of the primitive solar nebula. Our model will provide the photolysis rates of various species over the entire surface layer of the nebula, and from this we will evaluate the importance of UV photochemistry due to backscattered solar UV resonance line emissions on different parts of the nebula, at a number of important epochs.

2 Current Status

At this point in our study we have completed a cylindrically-symmetric Monte Carlo resonance line radiative transfer code for work in three dimensions. This code is currently being tested against standard results for problems involving cylindrical and spherical symmetry. As testing is completed we will begin a number of runs using the solar nebula model provided by Co-I Fegley.

3 3rd Year Plan

As described in the proposal, during the third year of the project the assigned tasks will be

Gladstone Run radiative transfer model for primitive solar nebula models, producing accurate radiation fields throughout the surface layers of the nebula for H I Ly α , He I 584 Å, and He II 304 Å backscattered resonance line emissions; use results to estimate photochemical kinetics of various regions of the nebula.

Fegley Interpret results for the various solar nebula models, studying the relative importance of photochemistry and thermochemistry; evaluate the effect of nebular transport processes on the photochemical products.

Once we have identified and assembled a set of representative solar nebula models, we will run our radiative transfer code to determine the radiation field (and thus the relevant photolysis rates of nebular gases) of H I Ly α , He I 584 Å, and He II 304 Å emissions, using appropriate values for the early solar fluxes of these lines. Once our set of runs is complete, we will examine the results to establish the importance of backscattered UV resonance line emissions.

Preliminary runs suggest that, while the He II 304 Å line may be of only marginal importance, the He I 584 Å line may be very important, even compared with H I Ly α , since He is very abundant in the nebula compared to atomic hydrogen. The much higher energy of the He I 584 Å would provide for enhanced photoionization in the solar nebula.

We are presenting our initial results at a special "Origins" session at the Fall AGU meeting (Dec. 8-12, 1997) that is being convened by Drs. Janet Luhmann and Jeff Cuzzi (SH01).